The Containerized Compost System™ (CCS) composts sewage, septage, and other putrescible organic materials in an entirely enclosed environment. Featuring a sophisticated process control system (CompDAC’s), the CCS facilitates natural degradation processes to convert Class B pathogenic waste into safely disposable and marketable Class A compost. Comprised of a mixer, conveyor, and computer-controlled bioreactors, the CCS handles waste from its raw or treated form to its final curing stage. Green Mountain Technologies’ airtight bioreactors provide highly efficient aerobic composting as well as cost-effective odor control, leachate containment, and waste conversion. Because the bioreactors are roll-off vessels that can be run individually or in parallel, the CCS can be sized to fit facilities processing one to 100 tons of sludge per day.

The integration of sophisticated process control capability with practical design concepts allows GMT to provide the most affordable in-vessel composting system on the market today. The modular design means that facilities can initiate their CCS with only one CompTainer™ if they choose, and then bring more into the system as demand grows. This modularity offers the benefit of minimizing up-front capital investment while ensuring that capacity can grow to meet demand. The modular design also makes the CCS extremely flexible in terms of responding to problematic batches of compost and peaks in processing demand.

Another feature minimizing start-up costs is the compatibility of the CCS with non-specialized equipment. The CompTainers™ fit any standard cable-lift (roll-off) truck. Similarly, any manufacturer can supply the wheel-loaders and screener. The CCS is proven effective in all weather conditions, even in extreme winter cold. The efficiency and year-round performance of the CCS ensures maximum cost recovery.

For what Applications is the CCS Recommended?
Any organic sludge, raw or treated, will find a suitable degradation environment in the Containerized Compost System. The CCS has been used to compost a variety of materials from fish waste to cotton mill sludge. If the sludge has been dewatered, it will be ready for mixing and loading into the CompTainer™. If it has not been dewatered, it can still be treated in the CCS, just after an additional step with Green Mountain Technologies’ DeTainer™, a vessel for polymerizing and dewatering liquid waste. For a facility that already composes with an open-air method, converting to the CCS will enable them to reduce odors, collect leachate, provide a cleaner work environment, and protect their compost process from ambient weather conditions. For a facility that does not already compost but would like to, the CCS will allow them to compost without the regulatory constraints and public opposition associated with other composting methods.

For what Applications is the CCS not Recommended?
The CCS does not usually prove economical for facilities processing more than 35,000 tons of sludge per year (>100 tons per day) or less than 365 tons per year (<1 ton per day). It is not feasible for a site where electricity cannot be delivered. The CCS is not...
recommended for composting municipal solid waste consisting of unsorted garbage. Furthermore, because it is an aerobic system, the CCS is not used for collecting biogas associated with anaerobic, methane-producing reactors.

**Description of Equipment**

**CompTainer™**
At the heart of the CCS is the custom designed, mobile, air-tight bio-reactors called the CompTainer. The CompTainer™ is configured to be moved and emptied by a standard roll-off truck, either hook or cable lift. Due to high temperatures, high humidity, and the presence of organic acids, the composting environment is corrosive. Because the composting environment is entirely contained within the CompTainers™, large building structures, mechanical equipment, and workers are not exposed to hot and humid process air. Furthermore, the CompTainer™ interior, including perforated flooring, is fabricated from stainless steel to prevent its own corrosion. There are two sizes available with a processing capacity of 40 or 50 cubic yards. Each CompTainer™ is approximately 24’ long x 8’-6” wide x 8’6” to 9’6” high.

**CompDAC’s**
Composting is carefully controlled inside these bio-reactors by a fully automated aeration control system that offers a variety of process control regimes as well as air recirculation and air flow reversal.

**CompMixer**
Mixing is the critical step for preparing waste for thermophillic composting. Designed to mix wood chips or ground yard waste with organic waste, uses four augers to blend materials. The mixer can be stationary and powered by an electric motor, or mobile and powered by a tractor PTO.

**CompLoader™**
GMT’s specialized conveyor belt requires approximately 15’ of travel space to load the CompTainer™. The specific conveyor length and incline are established by each site’s layout. A variable speed hydraulic motor powers the 24” wide PVC conveyor belt. Before dropping into the CompTainer™, material on the conveyor belt passes through a high-speed flail, which further breaks up clumps. The CompLoader™ is self-supporting on four wheels with a two-wheel ground drive for positioning the conveyor. For winter operations, the CompLoader™ should be inside a building or under a roof.

**Biofilter**
The biofilter removes odors by passing the air through a bed of organic materials. Bacteria grow on the media and break down and absorb the odor compounds. GMT uses roll-off containers for biofilter vessels to make the installation and operation of the biofilter simpler. The biofilter media will last from 6 months to two years depending on the amount of ammonia and other compounds in the process air.

**Description of Operations**

**Receiving**
The waste is typically trucked into the facility and dumped onto an enclosed tipping floor. Organic waste is visually inspected when discharged on the tipping floor, and obvious contaminants are removed.

**Feedstock Preparation**
One of the most critical elements in composting is the preparation of properly formulated mix of materials. While certain conditions can be managed during composting in the CompTainers™, the main characteristics of the biomass are established in the preparation stage - C/N ratio, moisture content, structure and particle size, and pH.

**Mixing**
A wheel-loader scoops the necessary buckets of waste from the appropriate storage bins and deposits the material into the mixer. If additional moisture is required above that contained in the feedstock material, water or leachate will be added to achieve the 45 to
70% optimal moisture conditions. Once the biomass material has been well blended, it is loaded by conveyor directly from the mixer into CompTainers, which are then transported by roll-off vehicle to the outdoor compost pad.

**Active Composting**

Active Composting The composting process is controlled within the enclosed CompTainer™. Each CompTainer has a raised perforated floor to allow for the control of aeration and collection of leachate. Aeration hoses are attached to CompTainers at the bottom and top for complete control over process air and odour emissions.

The CompDACs is a closed loop aerobic compost batch controller. It relies on blowers to remove heat from the compost, supply oxygen, and to maintain a relatively uniform temperature throughout the composting mass. The CompDACs leads each batch through a sequence of up to three “control regimes” each lasting several days. Multiple control regimes are used with pathogenic materials that must be held at an elevated temperature for a short pathogen reduction, then are best returned to more biologically active temperatures for optimal stabilization.

In a typical setup, the goal of control regime No. 1 would be to obtain pathogen reduction (>55°C for 72 consecutive hours). Then control regime No. 2 objective would be vector attraction reduction (average >45°C for 14 days). Control regime No. 3 is typically used for a drying stage.

Moisture levels are set with initial mix between 65%-55%. The CCS handle moisture levels as high as 65% due to its high thermal efficiency. With the high percentage of re-circulated process air, drying out is also not typically a problem.

If necessary, CompTainers can be discharged in the receiving/preparation building for reconditioning at any time during the thermophilic cycle, and then reloaded. This flexibility allows for adding moisture, improving structure, adjusting C/N ratio, etc., although experience indicates this is seldom required.

**Curing**

Curing is the final stage of composting in which stabilization of the compost continues but the rate of decomposition slows to a point where forced aeration is no longer required. Curing takes place on an outside covered pad. CompTainers are transported by roll-off vehicle to the curing pad where the biomass is discharged. The biomass, which is relatively stable at this point, is formed into windrows or static aerated piles, depending on space. Because the biomass is relatively stable, little ongoing management of the material is required during the estimated 50 to 60 day period necessary to reach stabilization and maturity.

**Finishing**

After the compost has cured, it is transported to the finishing area for screening to produce a higher value finished product. This screening is also the final contaminant removal process. The screened oversized fraction can be recycled as amendment. Additional curing may be required after screening.

**Site requirements**

Each CompTainer™ requires approximately 12‘x30’ of level concrete for its footprint and duct work. In addition, 50 feet of access room is required in front for the roll-off truck. An enclosed receiving/preparation area is recommended with solid flooring for the mixer to be bolted down. Ideally, the curing piles are also kept under cover.

**Automated Controls**

The CompDACs is operated by a Windows based PC, which provides remote monitoring, user interface, data storage, and report generation. This PC is connected to the blower speed controllers and monitoring nodes. The two temperature sensors are inserted
in the CompTainer, one near the top and one near the bottom of the composting mass. The CompDACS compares these temperatures and their difference with user determined setpoints and in turn controls the amount and the direction of the air delivered to the CompTainer by manipulating the blower speed and the damper position.

**Process Time**
Fourteen to twenty-one days of active composting is typical to produce a semi-mature compost with negligible odors and negligible leachate. After this time, the compost requires virtually no management (i.e. turning) and will not attract vectors; it is therefore environmentally safe and appropriate for being cured outdoors under cover.

**Feedstock**
The key concern with operating any composting system is to provide as clean or uncontaminated a feedstock as possible and to adjust the carbon/nitrogen ratio to the most usable proportions. Feedstock, or bulking material, can consist of paper wastes, corrugated and waxed corrugated cardboard, box board, wood waste (pallets, saw dust & shavings, solid wood trimmings, C&D wood, tree trimmings, etc...), leaf & yard wastes, animal wastes, and bedding materials. If the ratio of carbon/nitrogen is below the optimum blend of 30:1, the excess nitrogen is converted to odorous ammonia gas. The appropriate choice in quantity and type of bulking material will prevent such a condition. The characteristics of the end-product are determined largely by the characteristics of the feedstock materials, with the degree and quality of source separation having a direct impact on the level of contamination and product quality.

**Extreme Weather Conditions**
The CCS has been proven to work in cold, hot, wet, or dry climates. During extremely cold weather the operator can set the reversing temperature to a tight interval (1-2°C) to reduce the heat loss from the compost. The aeration system can re-circulate up to 90% of the process air, which effectively preheats the incoming air and prevents freezing at the contact faces. Furthermore, the operator may also increase the temperature set-point from the standard 60°C (PFRP) and 48°C (vector attraction reduction), to 65°C. The CCS works extremely well in dry climates because moisture is retained in the compost by both the automatic reversing aeration system and the limited evaporative losses.

**Sizing Your CCS**
The Containerized Composting System, by virtue of its modular design, may be expanded as your composting needs increase. Each CompTainer™ is capable of processing approximately 360 to 460 tons of biomass per year. Additional CompTainers™ can be purchased and readily installed at any time; so again, a conservative approach can be taken in the initial sizing of your facility. For sludge from a treatment plant, a typical wastewater treatment plant will generate one dry ton per day of sludge per 10,000 people. Each CompTainer can process between 2-3 dry tons depending on dryness of the dewatered cake. Therefore, a community of 20-30,000 people would fill one CompTainer per day. The volume capacity required is of course greatly dictated by the volume of bulking material used. The ideal ratio of bulking material to organic waste varies based on moisture, density, and carbon/nitrogen ratio of the waste. Green Mountain Technologies provides sizing calculation models on request for each CCS application.

**Employee Safety**
From an employee health & safety perspective, the CCS system provides a work environment superior to most other composting technologies. No aggressive equipment for agitating compost is utilized, and workers are not exposed to the harsh environment associated with thermophilic composting because all such activity is contained within the bioreactors. Additionally, each facility is designed with respect to federal and local regulations regarding worker health and safety. The most hazardous stage in the composting process is the receiving and mixing of the raw waste, where the toxicity of the material is of course characterized by its source. OSHA guidelines and Material Safety Data Sheets should already be in existence for the raw waste.
Meeting Regulations
The CCS will produce stability levels as dictated by EPA 503 regulations and ensure pathogen kill through exposure to temperatures of 55°C or higher over a 3 day period. Temperatures as high as 65 - 70°C may be reached, destroying pathogens, viable seeds, and all forms of invertebrates and their eggs. The thermophilic phase of composting is the temperature phase (above 40°C), during which time the biomass undergoes rapid decomposition and stabilization. This phase is when "vector attraction reduction" occurs. (14 days for Biosolids above 40°C by US EPA Reg 503) Following the thermophilic phase, biomass is essentially unattractive to vectors of any type, and may be cured outdoors.

Odor Control
A two-tier strategy for minimizing odour release from the facility is integral to the CCS design. The first strategy involves minimizing the generation of odour during the compost processing phases, and the second strategy provides for the filtering of air leaving the CompTainers™ and receiving/preparation building.

Proper formulation of the biomass, and effective process management are the keys to controlling odour generation. Process control offered within the CompTainers based on temperature and oxygen levels will minimize the possibility of anaerobic conditions developing. Furthermore, the judicious application of forced aeration through the biomass will result in reduced loss of nitrogen (through volatilization as ammonia) and other odorous compounds. An optimal carbon/nitrogen ratio will also help to avoid odour problems. In addition, all exhaust air from the CompTainers and receiving/preparation building is collected and treated through a biofilter before being released to the environment.

Leachate Control
Leachate that may be generated during the thermophilic composting phase in the is captured in the CompTainers™. The leachate may be continuously drained or held under the aeration floor until the CompTainer is emptied. The volume of leachate varies between 0 and 500 gallons depending on weather and waste.

Service and Warranty
Comprehensive start-up training for operating staff of the composting facility is included in the purchase of a CCS. Beyond the start-up period, technical support will be provided for three years at a rate of $500/day plus expenses per employee. All GMT equipment is covered.